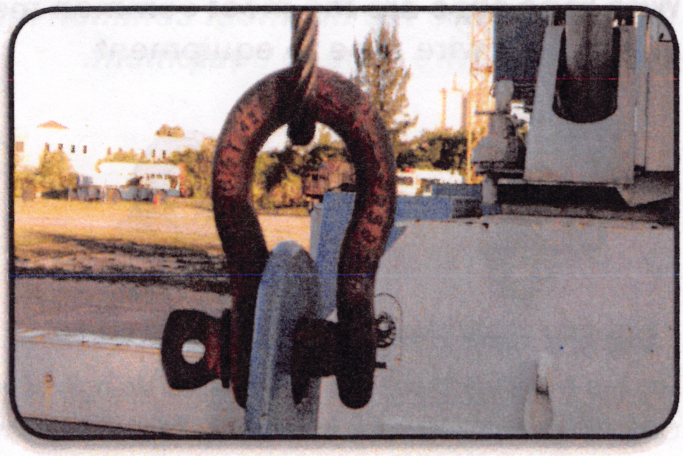
Module 13
Hardware



Learning Objectives

By the end of this section, you will:

1. Know how the hardware used in rigging affects the operation and safety of mobile cranes.
2. Know the requirements for proper rigging attachments.
3. Understand how to properly apply wire rope clips.
4. Know the use and application of U-bolt and fist grip rope clips.
5. Calculate the number of clips and the spacing of clips using the Rule of Thumb formulas.
6. Describe the five steps for proper clip installation.
7. Know the different types of shackles.
8. Know the rules for proper shackle use.
9. Understand how to inspect the hook.
10. Identify the three typical means of dead end attachment.
11. Understand the rules for eye bolts.
12. Know the different types of fittings.
13. Be aware of how and why spreader and equalizer beams are used.

Only the proper type and style of rigging attachments should be used.

Why?

» Extreme loads and stresses are placed on these items and their failure can result in injury or equipment damage. Other equipment may look similar, but their function may be very different.

What are the four requirements for proper rigging hardware?

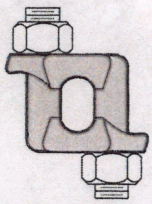
» Be of the forged type.

» Have size stamped on them.

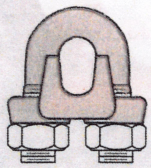
» Size and capacity.

» Manufacturer.

Wire rope clips are the most common method of creating an eye or attaching a wire rope to equipment.



Fist grip cable clamp



U-bolt cable clamp

Efficiency
80% below 1 inch
90% 1 inch and above

The two types are U-bolt and fist grip. The strength of the wire clip depends upon how they are applied. Clips will generally develop 80% of wire rope strength when properly applied.

Compare U-Bolt and Fist Grip Rope Clips.

U-Bolt Rope Clips

» U-shaped section must be on the dead or short end.

» Clips should be tightened prior to applying tension and again after load is applied.

Fist Grip Rope Clips

» Provides a wider bearing surface.

» Wrench can be rotated in full circle to facilitate fast installation.

» Available in J clips and double base clip.

OSHA regulations prohibit the use of clips to create eyes for slings used in overhead lifting.

Eyes in wire rope bridles, slings, or bull wires shall not be formed by wire rope clips or knots. Sling eyes should be of the type made with a Flemish splice and a hydraulic press swaged fitting.

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These two formulas should be used when applying rope clips.

1. **Number of clips - Rule of Thumb formula**
   - **number of wire rope clips = the diameter of the rope x 3 + 1 to the next whole number**
2. **Spacing of clips - Rule of Thumb formula**
   - **spacing of wire rope clips = the diameter of the wire rope x 6**

OSHA 1926.252 (f)(2)(Table H-2)

ASME SETTING THE STANDARD B30.5 5-1.7.3b

Always follow manufacturers recommendations.

What are the five steps for proper U-bolt clip installation?

» Place first clip one width from dead end of rope, U-bolt over dead end, tighten bolts evenly to recommended torque.

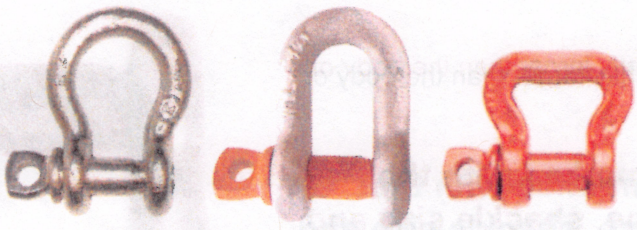
» Apply second clip nearest eye as possible, U-bolt over dead end, snug bolts but do not tighten.

» Evenly space remaining clips between first two.

» Tighten all nuts to recommended torque, apply tension.

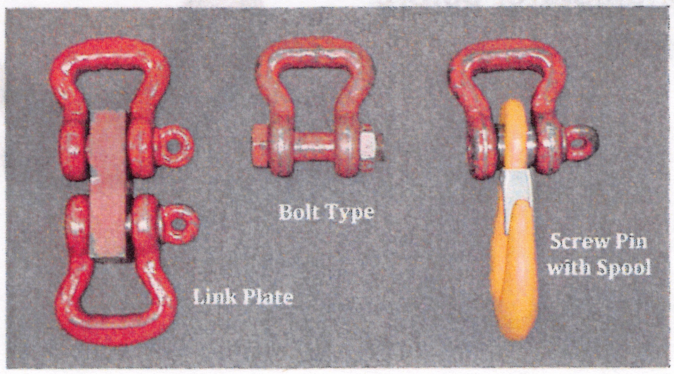
» Recheck nut torque after rope has been in operation, re-apply tension.

There are three main types of shackle bodies.



Anchor **Chain** **Synthetic**

Synthetic Sling Saver Shackles.

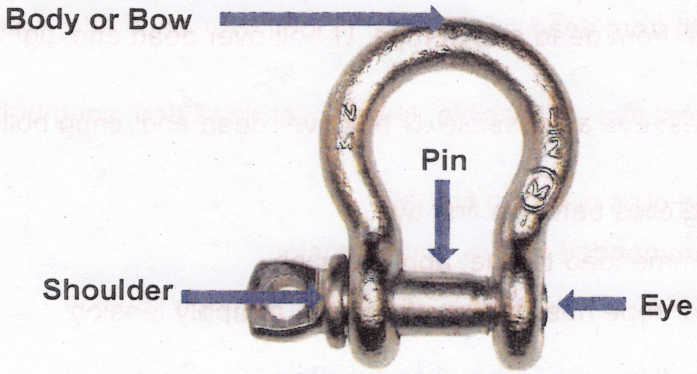


The three main types of shackle pins are round, screw and safety.

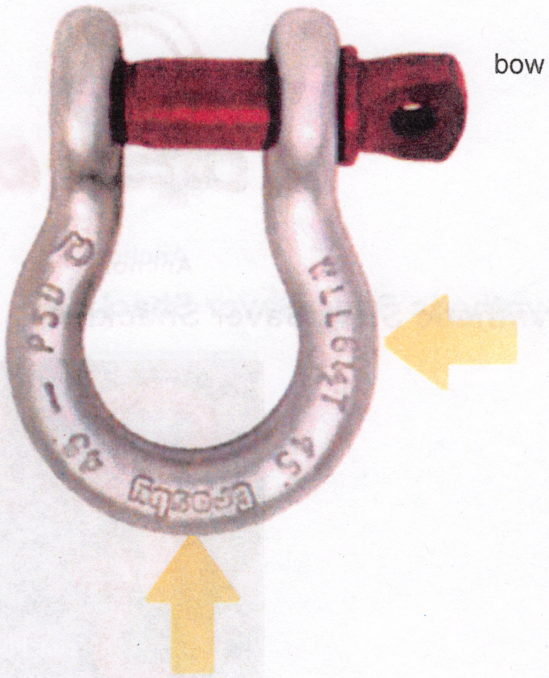
Round Screw Safety

Screw pin is most common for both anchor and chain types.

The size of the shackle is determined by the diameter of the body.



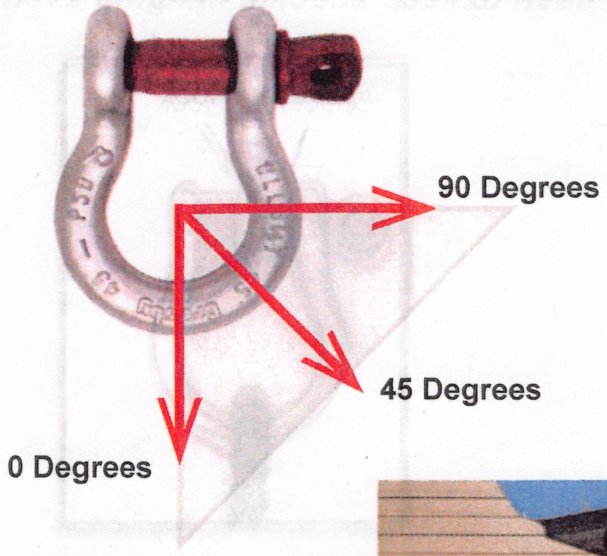
The pin will always be slightly larger than the body or bow of shackle.



Most shackles are marked with the manufacturer's name, shackle size and WLL.

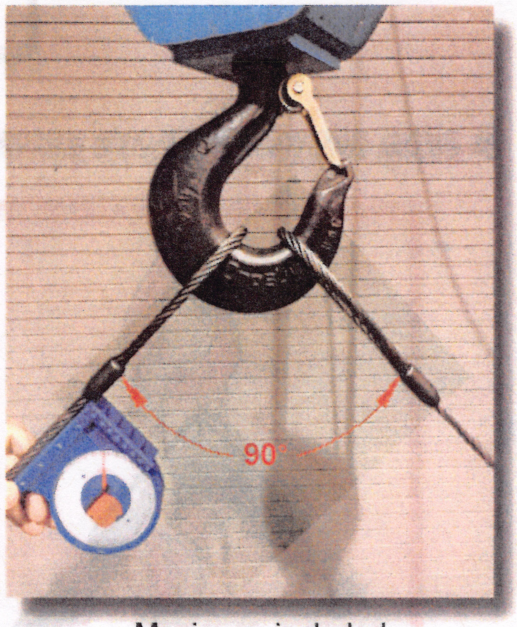
Check with the manufacturer before side loading a shackle.

Angle of Side Load	Loss of WLL
0 degrees or inline	None
45 Degrees	30% Loss
90 Degrees	50 % Loss

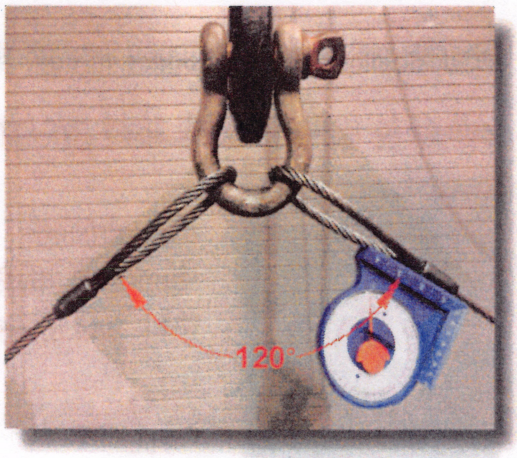


What are some of the rules for proper shackle use?

- Always use a cotter pin when required.
- Use proper pin, never replace with a bolt.
- Never use a screw pin shackle if the pin can roll under load.
- Shackle pins are:
  1/16 inch larger than the bow sizes up to 1/16 inch.
  1/8 inch larger than bow sizes 1/2 inch to 1-5/8 inch.
  1/4 inch larger than the bow sizes 1-3/4 inch and over.
- Generally shackles are meant for in-line pulls.
- Larger size should be used when lifting a load with two slings spread out at wide angles.
- The pin of a shackle is hung on the hook, loads are placed in the anchor part of the shackle.
- Washers can be used as spacers to keep shackle hanging evenly.

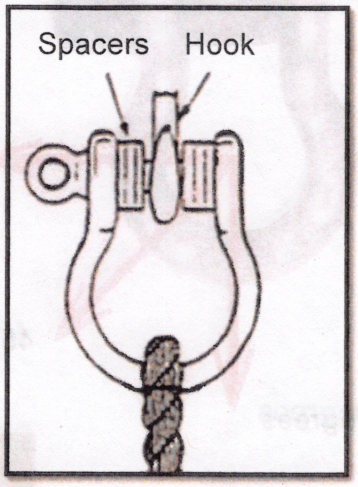


Maximum included angle for hooks.

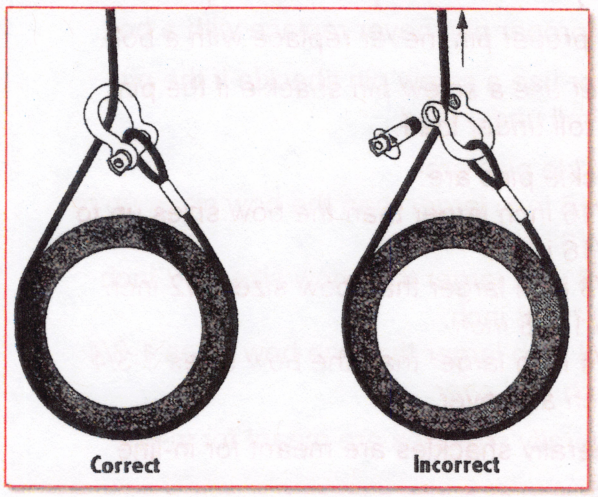


Maximum included angle for shackles.

Spacers can be used to keep shackle hanging evenly.



A sling allowed to move across a shackle pin may unscrew it.

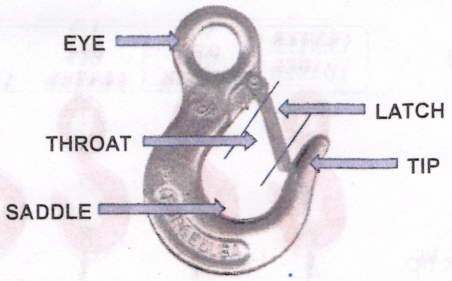


Shackle pins should be rigged through sling eyes or put on a hook.

What is wrong with this picture?

- No markings.
- Shouldn't have been used for lifting.
- WLL was probably exceeded.

Hooks have five main point of inspection.



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1910.180(d)(3)(v)
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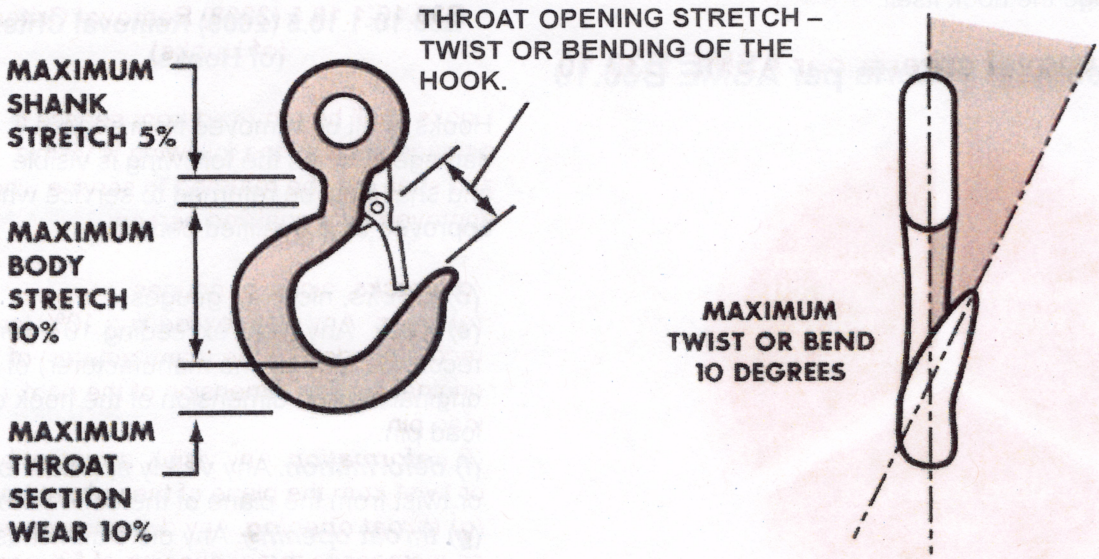
OSHA regulations require hook inspection for damage or distortion.

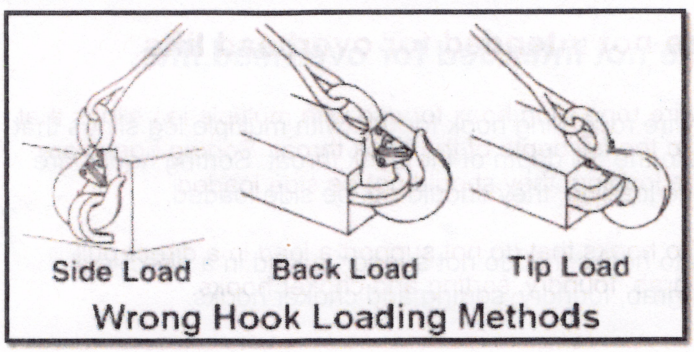


Hooks should be inspected for wear, cracks, nicks, gouges or corrosion. Safety latch should be in good working order. Overloading or tip loading will cause throat of hook to open further than designed. A good rule of thumb any recognizable defects the hook should be discarded.

All hooks should be made of forged steel. Grab and sorting type hooks can be made from other materials. All hooks should be equipped with safety latches.

Forged hooks with stamped rating are best quality.

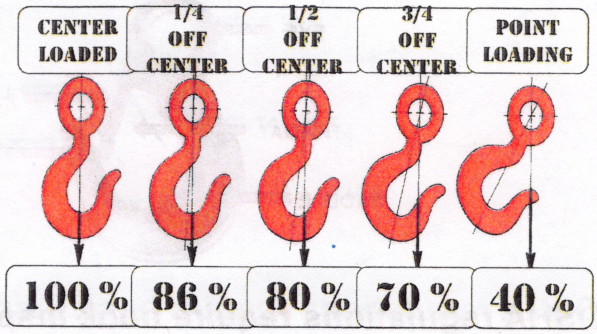
Improper hook loading reduces the load rating and can damage the hook itself.



Hook load rating is decreased as the amount of tip or point loading increases.

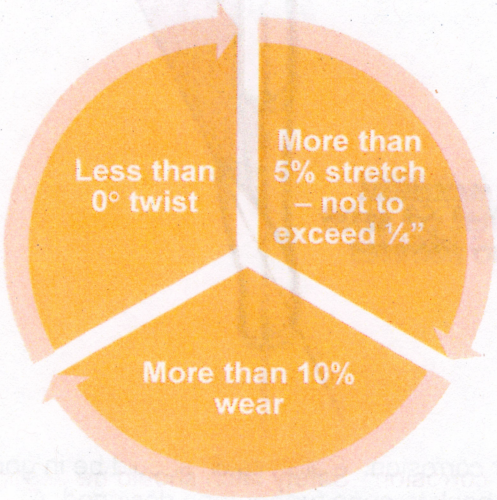
Safe working load is reduced if the load is applied between the saddle and the hook tip.
100% rated load when load is in saddle.
86% rated load when load is 1/4 off center.
80% rated load when load is 1/2 off center.
70% rated load when load is 3/4 off center.
40% rated load when load is point loaded on hook tip.

Improper hook loading reduces the load rating and can damage the hook itself.



B30.10-1.10.5 (2009) Removal Criteria (of Hooks)

Hook removal criteria per ASME B30.10



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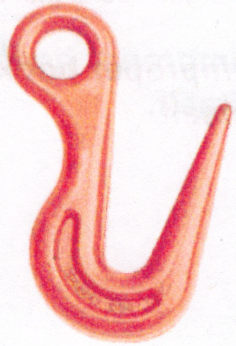
B30.10

Hooks shall be removed from service if damage such as the following is visible and shall only be returned to service when approved by a qualified person:

(d) cracks, nicks, or gouges.
(e) wear. Any wear exceeding 10% (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin.
(f) deformation. Any visibly apparent bend or twist from the plane of the unbent hook.
(g) throat opening. Any distortion causing an increase in throat opening of 5% not to exceed 1⁄4 in. (6 mm) (or as recommended by the manufacturer).
(h) inability to lock. Any self-locking hook that does not lock.
(i) inoperative latch (if required). Any damaged latch or malfunctioning latch that does not close the hook's throat.

Tip loading should be avoided.



Sorting hooks are not intended for overhead lifts.

The sorting hook is a wire rope sling hook for use with multiple leg slings that allow full engagement to the full depth of the hook throat. Sorting hooks are intended for straight line loading, they should not be side loaded.

ASME B30.10 applies to hooks that do not support a load in a direct-pull configuration, such as grab, foundry, sorting and choker hooks.

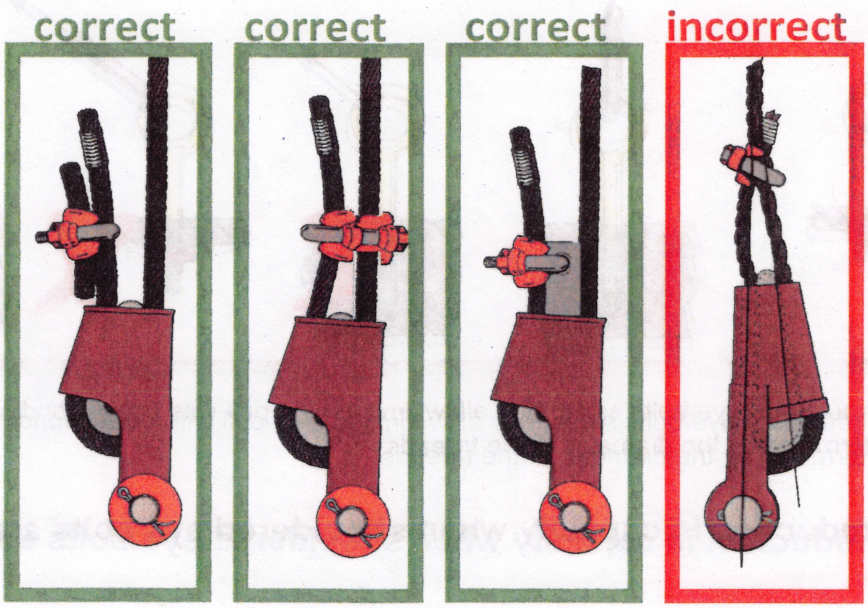
Wedge sockets are the rigging hardware used at the end of a wire rope to attach other lifting devices.

They must be attached in a manner that permits the load line to pull in a straight line from the pin when load is applied.

Proper attachment

No non-rotating rope

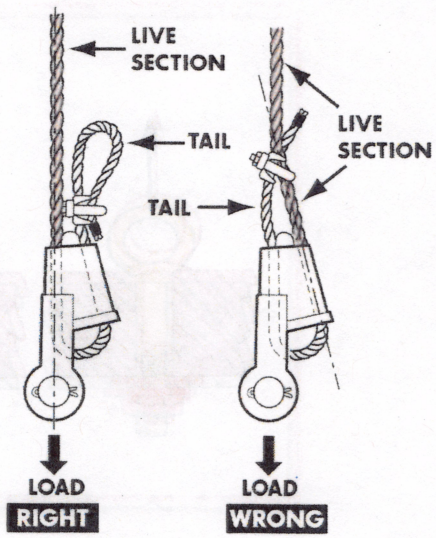
Which arrangement is wrong?



Attaching the tail to the live section of a load line with wire rope clips will reduce capacity of load line.

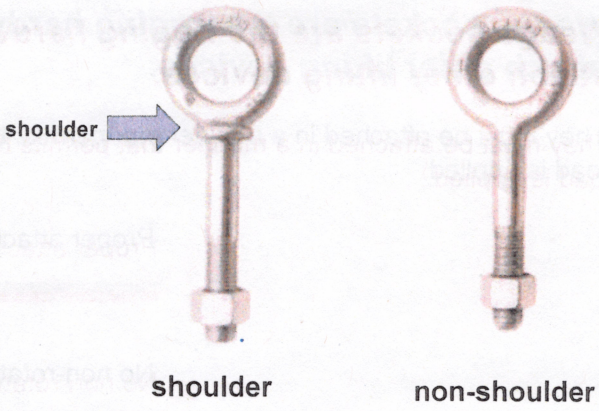
Dead end of wire should be pulled through the wedge socket further than necessary to allow for periodic cut off when there is wear at the socket. Safety regulations vary concerning dead end attachment and should always be checked.

- ***Diameter x 6 no less than 6" for IWRC.***
- ***Diameter x 20 no less than 6" for rotation resistant.***

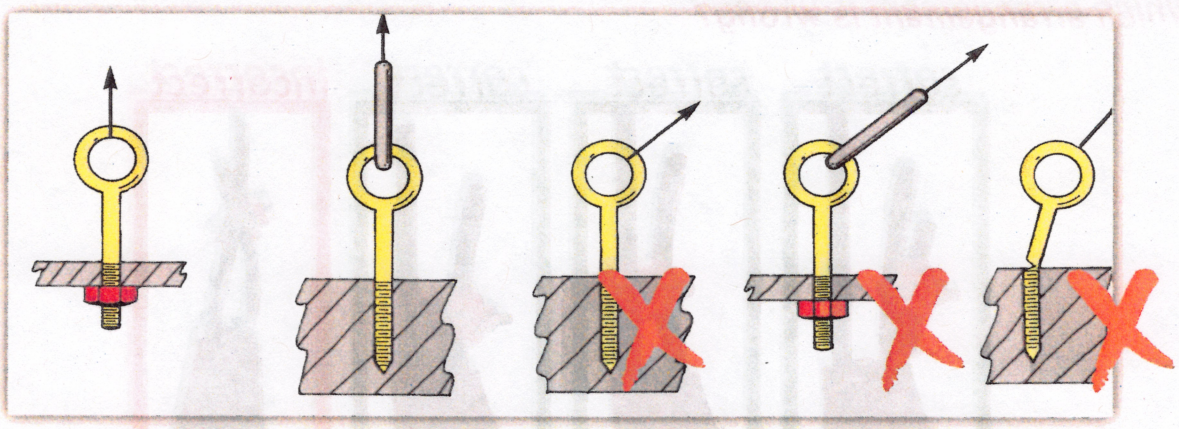


There are two types of lifting eyes or eye bolts.

Non-shoulder and shouldered eye bolts have the same safe working load for vertical loads. The resulting sling leg load is much greater than using two separate slings Eye bolts made of forged alloy steel are the best.

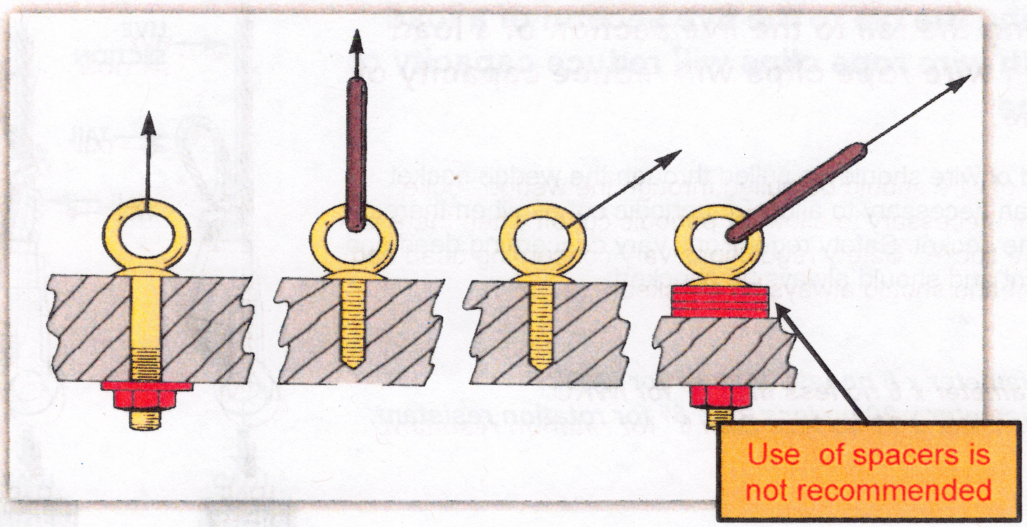


Non-shouldered eye bolts are for in-line pulls, not for side loading.

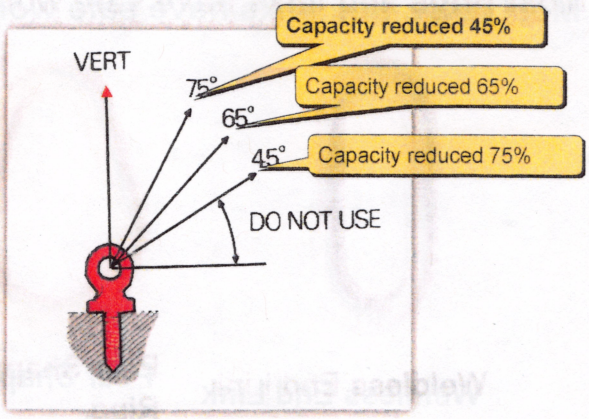


It's best to use shouldered eye bolts since they allow limited side pull with corresponding reduction of WLL. Size is determined by the diameter of the threads.

Substantial reduction in capacity when shouldered eye bolts are side loaded.

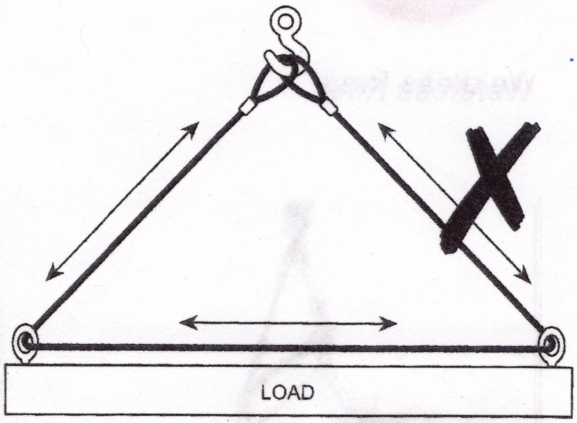


Capacity decreases as the side loading angle goes from vertical.



Eye bolts should be aligned so that attachments are in same plane – use a spacer if necessary.

Do not run a sling through eye bolts.



The stress on the slings and bolts will be many times higher than using 2 separate slings

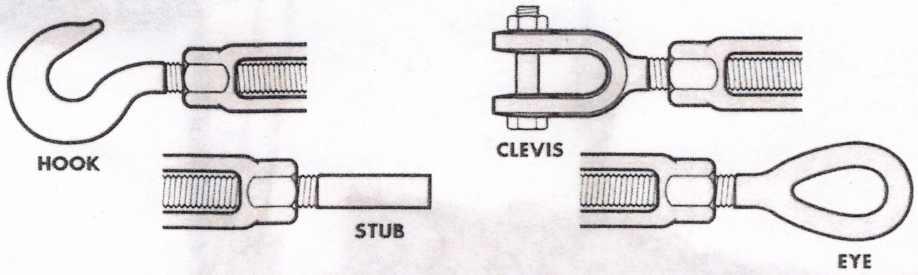
Turnbuckles have four types of end fittings.

Lock wire used to secure the frame to end attachment. Jam nuts add to the load on the thread.

With operations involving vibration, frame should be locked to end fitting.

Turnbuckles are only used for in-line loads and are weaker than wire rope of the same diameter.

Turnbuckles should be made of alloy steel and should never be welded.

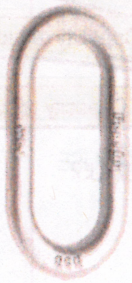


Turnbuckle size and SWL are determined by the diameter of the threads.

What are the different types of fittings?

- » Weldless rings.
- » Pear shaped links.
- » Swivels.
- » End links.
- » Master links.

Most rings and links have safe working load stamped on the forging.



Weldless End Link

Pear Shaped Ring

Weldless Ring

Spreader beams allow handling of loads without tipping, sliding, crushing or bending.

They are used to support long, hard to handle loads during lifting and they decrease the possibility of very long sling angles. Spreader beams reduce sling angles, require more head room and are subjected to compression forces.

Equalizer beams are used to level loads and distribute the weight from one crane to another during tandem lifts.